Fishery Data Series No. 98-19

Assessment of Arctic Grayling in Selected Streams of the Seward Peninsula, 1997

by

Alfred L. DeCicco

September 1998

Alaska Department of Fish and Game **Division of Sport Fish**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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by

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ABSTRACT

The number of Arctic grayling *Thymallus arcticus* over 249 mm in FL was estimated at 678 fish (SE = 139) in a 42 km section of the Nome River. Arctic grayling captured from the Nome River ranged from 112 to 485 mm in FL and in scale age from 1 to 10 years. Arctic grayling captured from the Eldorado River ranged in FL from 280 to 505 mm, and in scale age from 4 to 13 years. Of 93 Arctic grayling captured from the Eldorado River, six had been marked with OTC and were collected in order to validate aging techniques. Only 16 Arctic grayling were captured or observed in a 25 km section of the Solomon River.

Key words: Arctic grayling, *Thymallus arcticus*, population abundance, age composition, length composition, Seward Peninsula, Pilgrim River, Eldorado River.

INTRODUCTION

The Seward Peninsula-Norton Sound area of western Alaska supports the second largest amount of recreational fishing effort in the Arctic-Yukon-Kuskokwim (AYK) region. Over the past 10 years, annual sport fishing effort has ranged from 12,800 angler days in 1994 to 23,600 in 1991, with an annual average of 19,284 angler-days (Mills 1988-1994, Howe et al. 1995-1997). Reported freshwater fish harvests consisted primarily of Dolly Varden *Salvelinus malma*, Arctic grayling *Thymallus arcticus*, pink, coho, chum and chinook salmon *Oncorhynchus spp.*, northern pike *Esox lucius*, whitefish *Coregonus spp.*, and burbot *Lota lota*. From 1980 through 1991, Arctic grayling had comprised an average of 19.4% of the harvest of these species, but dropped to between 6.5% and 10.6% over the past 5 years (Table 1). The annual harvest has remained fairly consistent at about 1,200 Arctic grayling over the past four years.

The Seward Peninsula is the only area in Alaska outside of Bristol Bay which regularly produces trophy-sized Arctic grayling. Since 1983, 25% of the Arctic grayling registered in the Alaska Department of Fish and Game (ADF&G) Trophy Fish Program have come from the Seward Peninsula (ADF&G *Unpublished*).

Although not connected by road to the state highway system, the Nome area has approximately 420 km of maintained gravel roads which traverse the Seward Peninsula in three general directions from Nome (Figure 1). This road system provides angler access to many waters. Local concerns about the stock status of Arctic grayling and angler reports that the abundance of large-sized Arctic grayling appeared to be declining in some streams led the Alaska Board of Fisheries to promulgate a regulation in 1988 which reduced the daily bag limit of Arctic grayling on the Seward Peninsula from 15 per day (a combination of trout, Arctic grayling and char) to five Arctic grayling per day, five in possession, with only one over 15 inches (381 mm).

The first studies conducted by ADF&G on the basic life history and angler utilization of fish in the freshwaters of Seward Peninsula began in 1977 and continued through 1979. Nine streams were surveyed for fish presence and 147 Arctic grayling were sampled for age, weight and length. Angler counts were conducted periodically on 15 different streams (Alt 1978, 1979, 1980). Between 1979 and 1984, 88 Arctic grayling from the Fish/Niukluk rivers were sampled for age, length and weight (Alt 1986). During 1988, a project was initiated to survey Arctic grayling stocks on Seward Peninsula rivers and to estimate average catch and harvest per unit effort on surveyed streams (Merritt 1989). A total of 887 Arctic grayling were tagged and sampled for length and age on the Nome, Snake, Sinuk, Solomon, Eldorado, Pilgrim, Kuzitrin, Niukluk and Fish rivers and Boston Creek. Since 1989, population abundance, age at length,

Table 1.-Estimated freshwater sport fish harvests (catches are in parentheses) for Seward Peninsula and Norton Sound streams, 1980-1996. Data from the Alaska statewide sport fish harvest survey (Mills 1981-1994, Howe et al. 1995, 1997).

	Harvests (Catches) in Number of Fish						
Year	Days Fished	Salmon All Species	Dolly Varden	Arctic Grayling	Northern Pike	Burbot	Whitefish
1980	7,968	10,840	5,811	1,635	284	0	353
1981	10,879	6,564	3,981	2,104	303	0	123
1982	13,198	19,757	6,498	6,225	210	0	597
1983	12,678	10,189	9,779	8,241	798	0	148
1984	12,558	13,881	4,260	2,349	208	13	39
1985	18,141	3,401	5,695	4,501	56	175	70
1986	17,257	9,610	5,381	4,042	699	0	510
1987	20,381	5,415	5,506	4,600	906	0	272
1988	19,456	10,460	4,437	4,873	564	36	655
1989	15,443	8,548	7,003	4,205	648	10	453
1990	18,720	11,227	3,765	1,378	1,957	33	299
		(24,705)	(9,118)	(6,119)	(4,145)	(33)	(315)
1991	22,118	8,928	10,365	5,121	1,429	116	1357
		(15,561)	(25,425)	(23,160)	(4,257)	(116)	(1,409)
1992	19,351	11,778	2,178	492	479	0	46
		(35,473)	(5,726)	(5,772)	(3,742)	(0)	(165)
1993	17,055	6,634	5,702	1,378	537	96	95
		(16,920)	(21,961)	(13,223)	(2,117)	(107)	(196)
1994	11,757	12,215	2,981	1,200	376	0	67
		(21,048)	(7,254)	(6,853)	(1,731)	(0)	(172)
1995	13,428	5,316	2,908	1,037	215	45	247
		(14,250)	(7,806)	(5,788)	(1,856)	(56)	(321)
1996	16,777	12,138	3,662	1,192	410	0	27
		(29,208)	(7,140)	(6,342)	(1,747)	(0)	(54)
MEAN	15,716	9,818	5,296	3,210	593	25	459
	(16,442)	(22,764)	(12,061)	(9608)	(2,799)	(45)	(376)

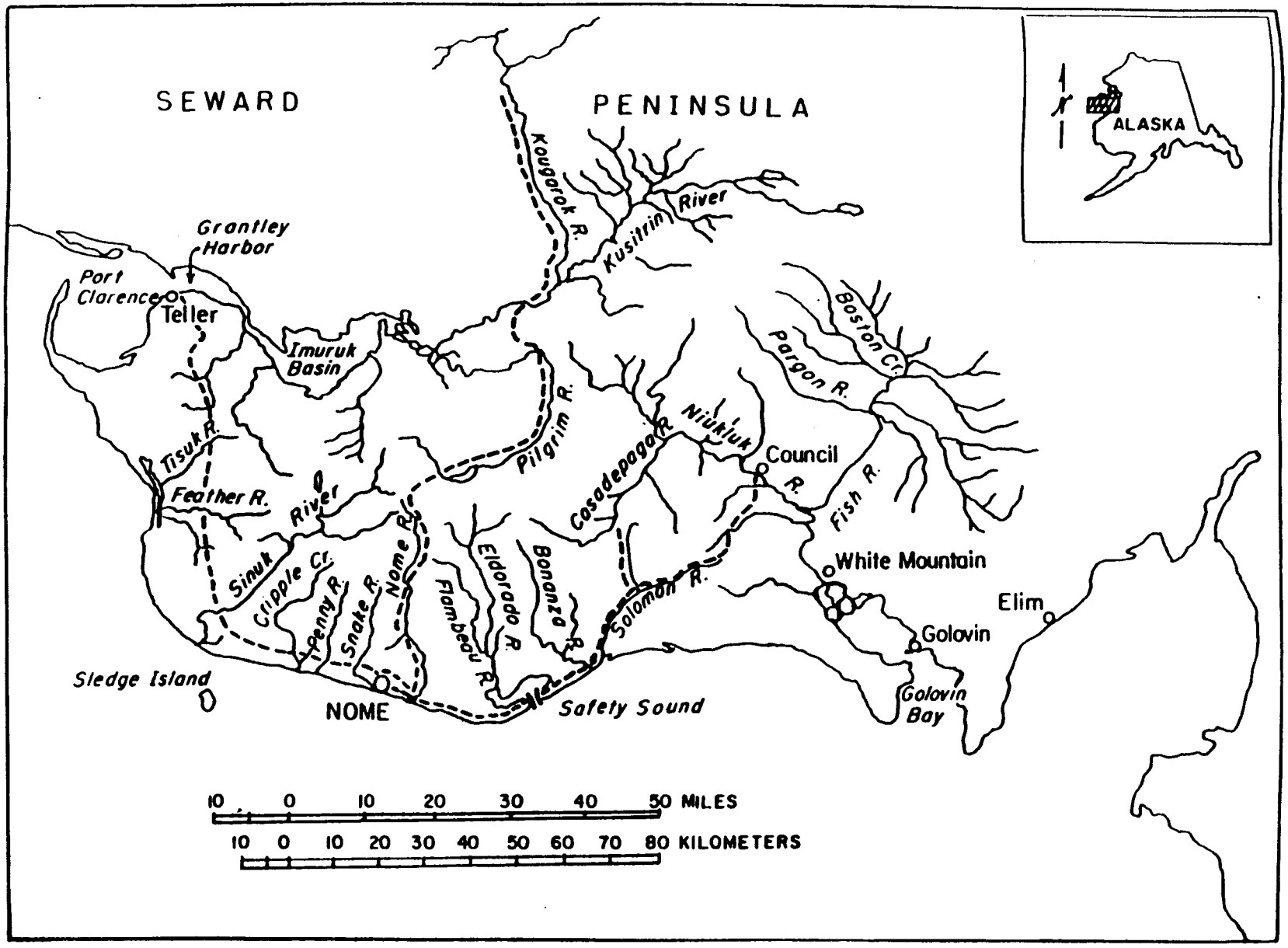

Figure 1.-The southern Seward Peninsula.

size and age composition have been estimated for Arctic grayling on the Niukluk, Fish, Pilgrim, Nome, Snake and Sinuk rivers (DeCicco 1990-1996). Problems with assigning ages to large Arctic grayling have been noted in recent years (DeCicco 1993-1995). Consequently, an age validation component was added to this project in 1994.

Several regulatory changes have recently been implemented based on data collected from these studies. The daily bag and possession limits for Arctic grayling in both the Snake and Pilgrim rivers have been reduced to two per day, only one of which may be over 15 inches (381 mm) in length. Very low abundances in the Nome and Solomon rivers resulted in the closure of these waters to Arctic grayling fishing by emergency order in 1992. These rivers were then closed to fishing for Arctic grayling by the Board of Fisheries in December 1997 after this project found that abundances in these rivers had not changed with five years of sport closure.

The long-term goal of this project is to achieve sustained yield fisheries for Arctic grayling populations through regulation. Project objectives in 1997 were to:

1) estimate the abundance of Arctic grayling greater than 249 mm FL in a the Nome River
2) estimate age and length composition of Arctic grayling for given length ranges in the Nome River
3) estimate the proportion of correctly aged otoliths from Arctic grayling marked with oxytetracycline and recaptured in the Eldorado River;

In addition, mean length-at-age for Arctic grayling in the Nome and Eldorado rivers was estimated. A task for this project was to sample, with a single sampling trip, the Arctic grayling population in the Solomon River to compare relative abundance to the population in the Nome River.

METHODS

SAMPLING GEAR AND TECHNIQUES

Arctic grayling in the Nome, Solomon and Eldorado rivers were sampled using hook and line, and a 50-m x 2-m, 6.5-mm mesh beach seine. Access to the upper Nome River and the Solomon River was by inflatable raft and on foot, while the lower Nome and Eldorado rivers was sampled using a 4.8 m outboard jet-powered riverboat.

Each Arctic grayling was measured to the nearest mm in fork length. Fish over 249 mm FL in the Nome River were tagged with individually numbered Floy FD-67 internal anchor tags which were inserted such that the "T" anchor locked between the base of adjacent dorsal fin rays. Each fish was also marked with a partial fin clip (Appendix A1). Scales for age determination were taken from the left side of the fish approximately midway between the dorsal fin and the lateral line down from the posterior insertion of the dorsal fin. Data were recorded in field notebooks and entered directly into EXCEL spreadsheets. Scales were cleaned with detergent and water, mounted on gummed cards and acetate impressions were made (30 seconds at 7,000 kg/cm^2, at 100^o C). Ages were determined by counting annuli from the acetate impressions using a microfiche reader. All scale impressions were read by a trained scale reader and the project leader. Age determinations follow procedures outlined by Yole (1975). Scale impressions with questionable readings were read a third time as necessary. If the age assignment was still in

question, the age sample was discarded. Regenerated scales were not aged. Data files were archived with ADF&G Research and Technical Services (RTS) in Anchorage (Appendix B1).

NOME RIVER POPULATION ABUNDANCE

A two sample approach using a Petersen mark-recapture estimator as modified by Bailey (1951, 1952) was used to estimate the abundance of Arctic grayling in the Nome River. The 42 km length of the Nome River assessed in this study includes the upper range of Arctic grayling distribution and the reach of the drainage assessed in previous studies (DeCicco 1993). The reach of the river was divided into four sections and sampling for the population estimate was performed along the entire length of each river section during both the mark and recapture events (Figure 2). The assumptions necessary for the accurate estimation of abundance in a closed population are (from Seber 1982):

1. there is neither mortality nor recruitment between sampling events (closed population);
2. fish have an equal capture probability in the first event or the second event, or marked fish mix completely with unmarked fish during the second sampling event;
3. marking does not affect capture probability in the second event;
4. marks are not lost between events; and,
5. marked fish can be recognized from unmarked fish.

Assumption 1 could not be tested directly. It was assumed that neither mortality nor recruitment occurred between events because both events were close together in time. Assumptions 2 and 3 were tested with two Kolmogorov-Smirnov two-sample tests (Conover 1980). The first test compared the cumulative length distribution of fish marked in the first sampling event (mark event) with the cumulative length distribution of marked fish recaptured during the second sampling event (recapture event). In the second test, the cumulative length distribution of fish captured during the marking event was compared to the cumulative length distribution of all fish captured during the recapture event. If the results of the first test showed that the samples were different ($P < 0.05$), size selectivity between samples was indicated. If the results of the second test showed that the samples were different ($P < 0.05$), recruitment, migration, or some other factor affecting the size distribution of the two samples was indicated. A more complete tracking of test results and consequences is contained in DeCicco (1994). All fish were released within the reach of the river in which they were captured. To meet conditions of assumption 4, all tagged fish were also marked with a fin clip or punch (Appendix A1). Assumption 5 was met by the close examination of all fish for the presence of the double mark or fin punch.

Capture probabilities were compared among sections to determine if there was movement among river sections between sampling events which might influence the abundance estimate. The marking event, working downstream through the four sections of the Nome River was conducted for eight days from June 24 through July 7. The recapture event was conducted during six days between July 8 and July 15. Because the sequence of sampling was the same in both events, this resulted in an 8 to 14 day hiatus between sampling events in a given location of the river. Two

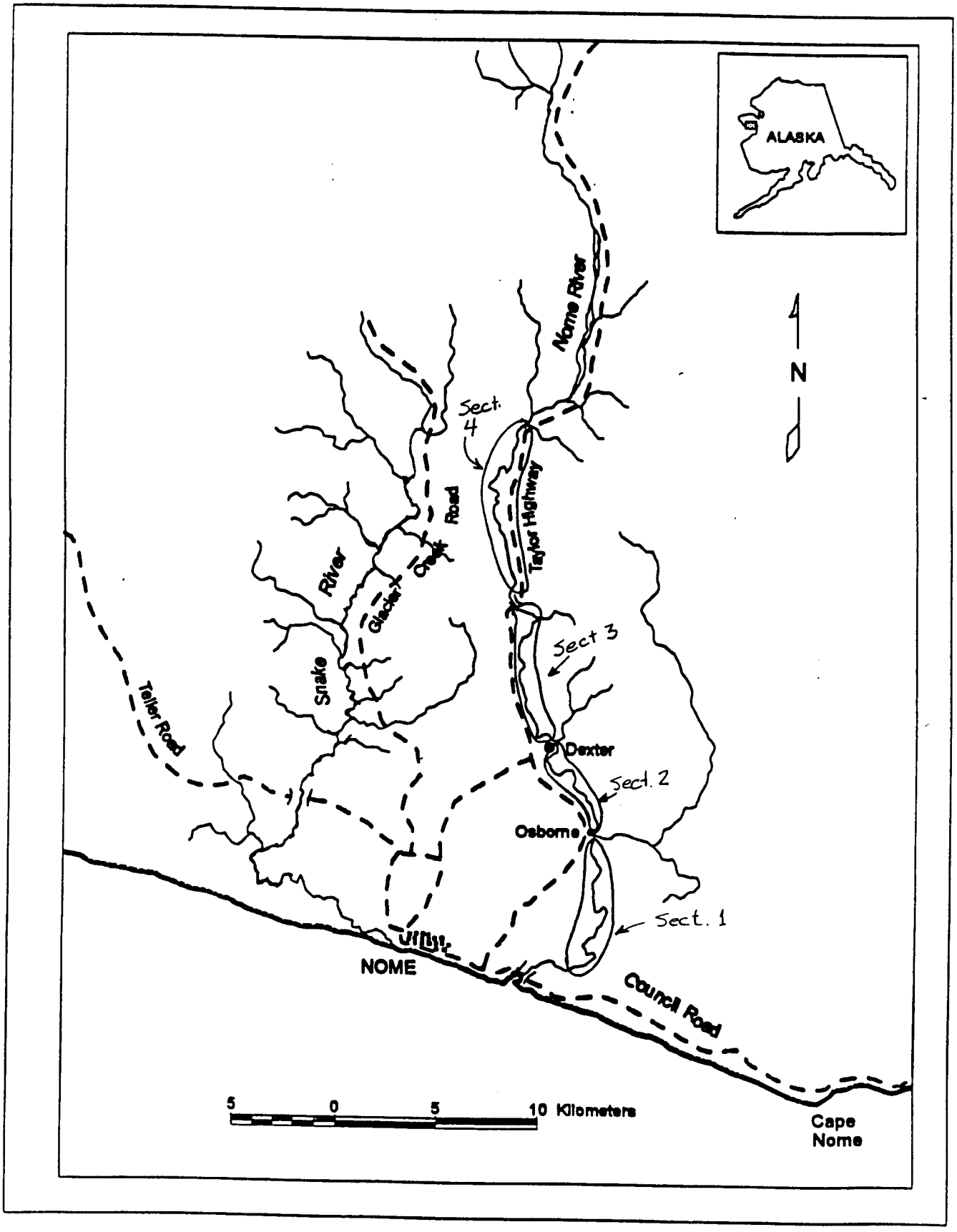

Figure 2.-Nome River with areas sampled during 1997.

crews were used during part of the second event which reduced the number of days required to complete this sample.

Population abundance and the approximate variance of the estimate were calculated with Bailey's modified Petersen estimator (Seber 1982):

$$\hat{N} = \frac{M(C+1)}{(R+1)} \tag{1}$$

$$V[\hat{N}] = \frac{M^2(C+1)(C-R)}{(R+1)^2(R+2)} \tag{2}$$

where:

M = the number marked during the first event;

C = the number captured during the second event;

R = the number captured during the second event with marks from the first event;

$\hat{N}$ = the estimated abundance of Arctic grayling during the first event; and,

$V[\hat{N}]$ = the approximate variance of the abundance estimate.

AGE COMPOSITION

Scales were collected from Arctic grayling sampled in conjunction with the abundance and age experiments. Ages were assigned to scales as indicated above to estimate age composition for the population in the Nome River. The proportions of fish in each age category were estimated as multinomial proportions (Cochran 1977, Thompson 1987).

The proportion in each category was estimated as:

$$\hat{p}_i = \frac{n_i}{n} \tag{3}$$

where:

n_i = the number in the sample from age category i;

n = the sample size; and,

$\hat{p}_i$ = the estimated fraction of the population that is made up of age category i.

The unbiased variance of this proportion was estimated as:

$$V\left[\hat{p}_i\right] = \frac{\hat{p}_i\left(1-\hat{p}_i\right)}{(n-1)} \tag{4}$$

Abundance of Arctic grayling by age was estimated as follows:

$$\hat{N}_i = \hat{p}_i(\hat{N}); \quad (5)$$

where:

$\hat{N}_i$ = estimated number of fish in age category i;

$\hat{p}_i$ = estimated proportion of fish in age category i; and,

$\hat{N}$ = estimated abundance of Arctic grayling.

Variances for Equation 5 were estimated using Goodman's (1960) formula:

$$V[\hat{N}_i] = \left(\hat{p}^2{}_i\, V\left[\hat{N}\right]\right) + \left(\hat{N}^2 V\left[\hat{p}_i\right]\right) - \left(V\left[\hat{p}_i\right] V\left[\hat{N}\right]\right); \quad (6)$$

where:

$V[\hat{N}]$ was obtained from the mark recapture analyses (see equation 2).

LENGTH COMPOSITION

Length composition of Arctic grayling residing in the Nome River was estimated in 25 mm length increments. Estimates of the proportion of fish in size categories followed the same procedures used for age composition (equations 3 and 4). Abundances and their variances by length category were estimated using equations 5 and 6.

MEAN LENGTH-AT-AGE

Mean length-at-age was calculated as the arithmetic mean length of all fish assigned the same age. Samples were combined across years to increase sample sizes. Standard deviations of the lengths of each age class were calculated.

AGE VALIDATION

Arctic grayling were captured in the Eldorado River as part of an ongoing study to validate aging techniques. Fish with Floy tags or adipose fin clips indicating that they carried oxytetracycline (OTC) marks were collected, kept cool and frozen at the first opportunity. Scales were collected from each fish not carrying a fin clip or tag. Frozen fish were transported to Fairbanks where otoliths were taken from all dead fish.

Upon completion of this study in 1998, otoliths will be imbedded in thermoplastic resin and ground in cross section through their origin on a horizontal diamond wheel. The otoliths will be placed flat ground side against a glass slide, stabilized in thermoplastic resin and thin sections (approximately 0.5 mm) prepared using a thin section grinder. Otolith sections will be photographed under the same magnification using both visible and ultraviolet light. Paired

photographs of each otolith will be compared to locate the position of the fluorescent mark in relation to the visible annual growth rings. In order to validate the passage of time (age), the numbers of annual growth rings past the fluorescent mark will be compared to the known passage of time between the OTC injection and the capture of the fish from which the otoliths were taken. Final results of this analysis will be presented in a subsequent report.

RESULTS

NOME RIVER POPULATION ABUNDANCE

The abundance of Arctic grayling >249 mm FL in the 42 km index section of the Nome River in 1997 was estimated to be 678 fish (SE = 139, CV = 20%). This section includes the area from Hobson Creek to the ADF&G counting tower located about 1.5 km upstream from the bridge on the Nome - Council road, and includes the majority of the river utilized by Arctic grayling.

The smallest of 195 Arctic grayling >249 mm FL marked and released in the Nome River was 250 mm FL and the smallest of 159 Arctic grayling >249 mm FL examined during the second event was 251 mm FL. The smallest of the 45 marked fish recaptured from the Nome River was 251 mm FL. One tag loss was detected, and two fish were killed during sampling in the Nome River during 1997.

A Kolmogorov-Smirnov two sample test of the cumulative length distributions of Arctic grayling > 249 mm FL marked versus those recaptured during the recapture event (test 1) failed to detect significant differences ($D = 0.15$, $P = 0.36$, $n_1 = 194$, $n_2 = 45$). A similar test of those marked in the first event and those examined in the second event (test 2) also failed to detect significant differences ($D = 0.07$, $P= 0.85$, $n_1 = 194$, $n_2 = 158$; Figure 3). A single unstratified abundance estimate was calculated for Arctic grayling greater than 249 mm FL. Fish from both samples were combined to estimate length at age, length composition, age composition, and age-length distribution (Appendix A2).

Recapture rates as a measure of capture probability were examined among river sections using contingency tables which compared the number of marked fish (R) with the number of unmarked fish (C-R) in the second sample and by comparing the number of marked fish not recaptured (M-R) with the number recaptured (R). Neither test showed significant differences among river sections (Test 1: $\chi^2 = 4.21$, df = 3, $P = 0.24$; Test 2: $\chi^2 = 0.73$, df = 3, $P = 0.87$).

To determine if movement of Arctic grayling between sampling events might have influenced the estimate of abundance, both the river sections and the locations (river km), where fish were marked and subsequently recaptured, were examined. Out of 45 recaptured fish, only three were recaptured from a river section other than where marked (all three recaptured downstream). Movement of one recaptured fish could not be determined because it had lost its tag. When movement was examined with location data by river km from mark to recapture, it was found that 38 of the 44 fish with recapture location data had moved 5 km or less, four moved between 5 and 10 km, and two moved 11 km (Figure 4). Based on these data, movement was not found to be a significant factor which might require an adjustment to the abundance calculation, or something other than a single unstratified approach to the estimate of abundance.

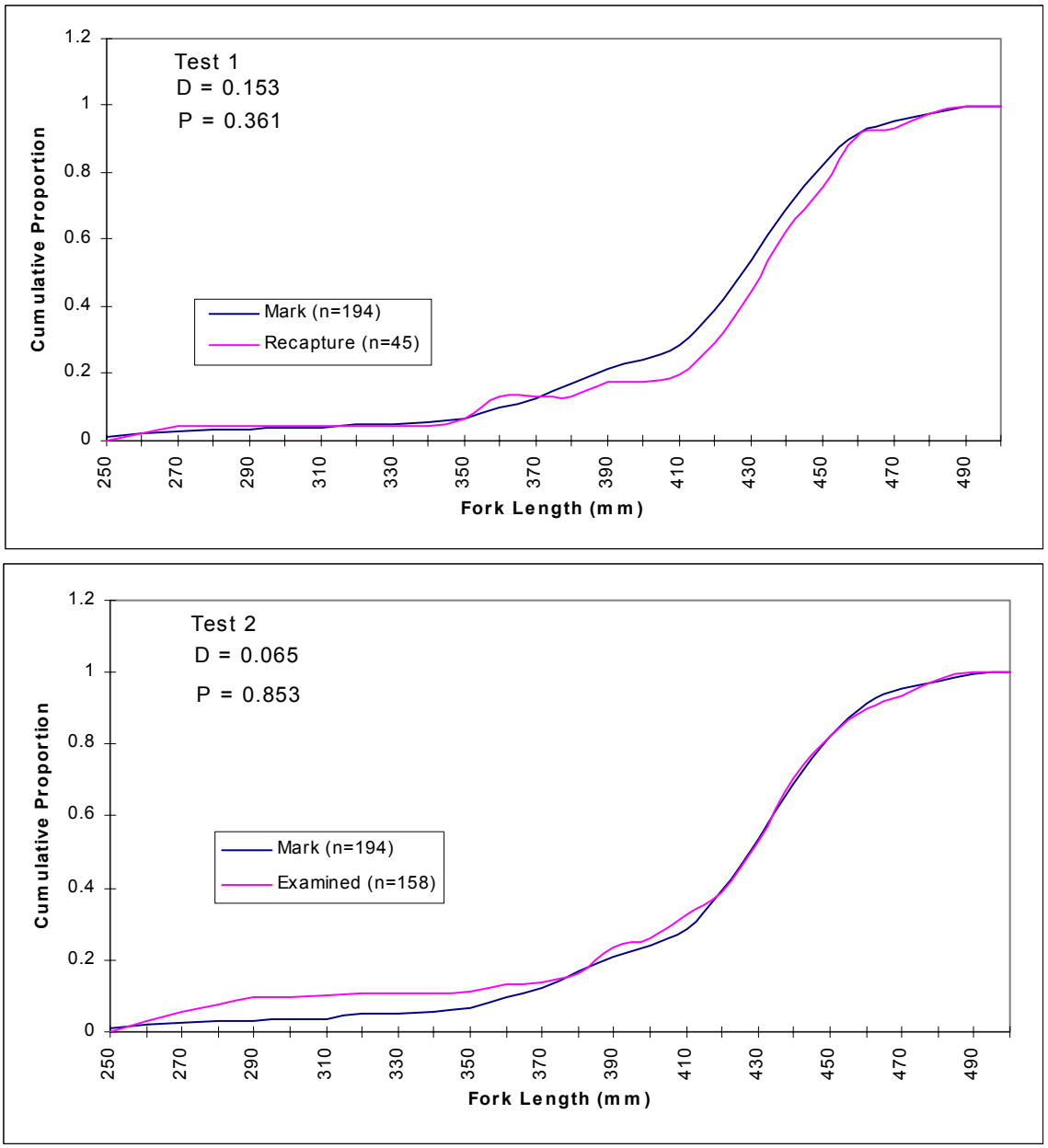

Figure 3.-Cumulative length distribution plots (tests 1 and 2) of Arctic grayling >249 mm FL sampled from the Nome River in 1997.

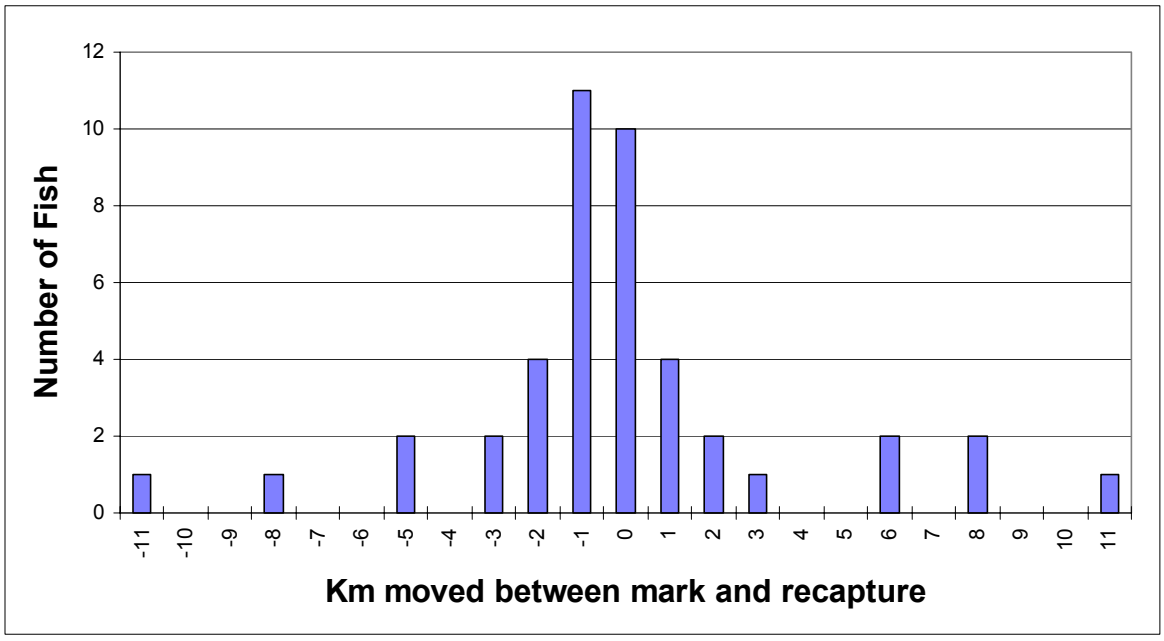

Figure 4.-Movement in km between mark and recapture of Arctic grayling in the Nome River in 1997.

AGE AND LENGTH COMPOSITIONS

Age and length composition and abundances by age and size category of Arctic grayling were estimated for the Nome River in 1997. Scale ages of Arctic grayling from the Nome River ranged from 3 to 10 years and were normally distributed around 7 years which comprised 23% of the entire population (Figure 5, Table 2).

The majority of the population comprised the three 25 mm length categories from 400 to 475 mm (70.5%; Figure 6, Table 3). The estimates were germane to those fish >249 mm FL and may be biased high in relation to the entire population. However, very few Arctic grayling smaller than 249 mm FL were captured or observed in the river, and it is thought that if size bias exists, it is small and that composition estimates are likely representative of the population. The

age and length distributions of Arctic grayling sampled from the Eldorado River in 1997 are also presented in Figures 5 and 6.

MEAN LENGTH-AT-AGE

Estimates of mean fork length-at-age were calculated for Arctic grayling sampled from the Nome, and Eldorado rivers (Table 4). When data were available, they were combined across years. Arctic grayling from the Eldorado River and Nome Rivers were of similar size at all ages. Age and length distributions of Arctic grayling sampled are provided in Appendices A2 and A3.

ELDORADO RIVER AGE VALIDATION

During 1994, 60 Arctic grayling in the Eldorado River were measured, weighed and injected with OTC for age validation. During 1995, 43 additional Arctic grayling were captured and marked for age validation. A total of 93 Arctic grayling were captured from the Eldorado River

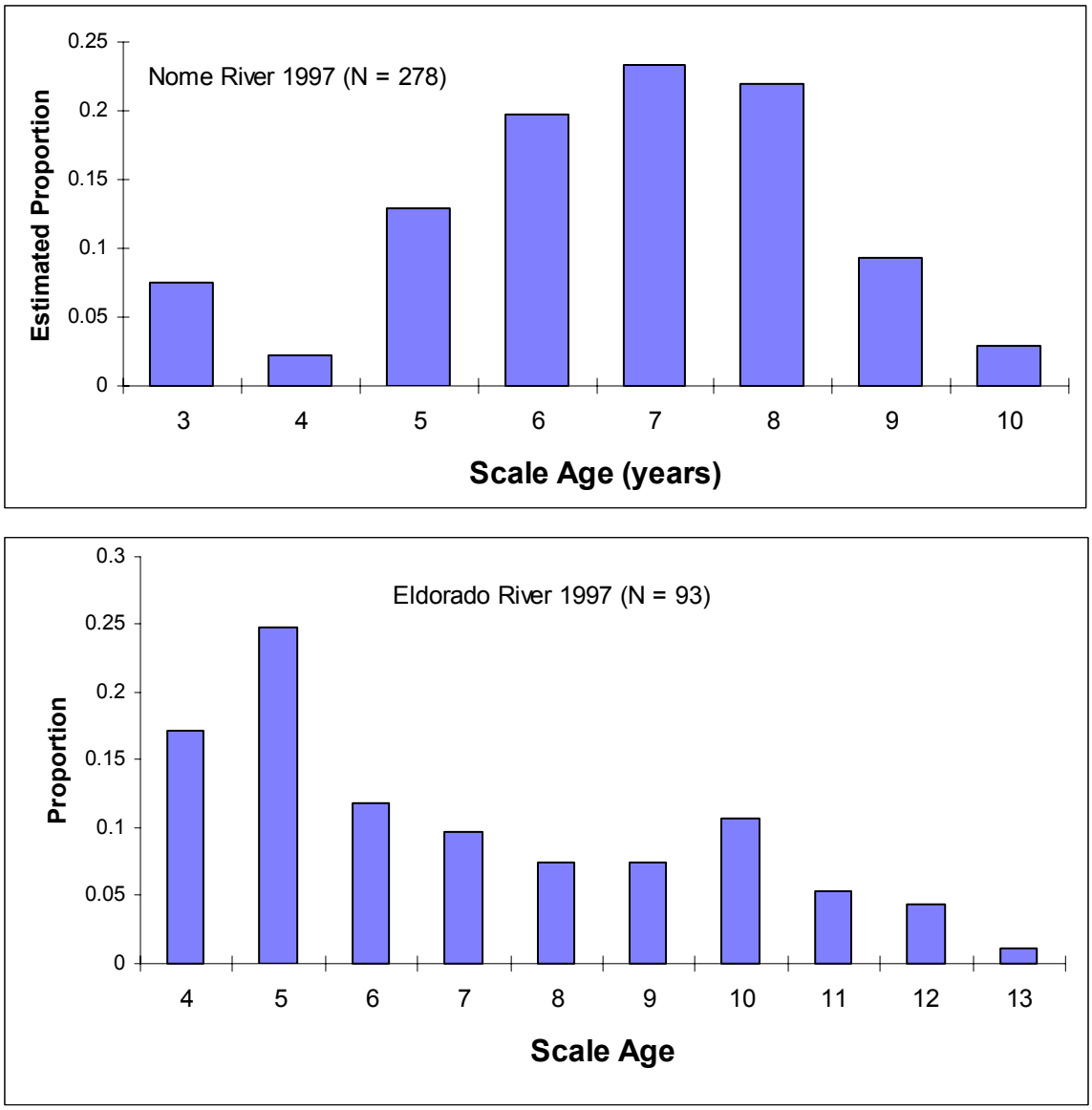

Figure 5.-Age composition estimates of Arctic grayling from the Nome River, and age distribution of Arctic grayling sampled from the Eldorado River in 1997.

Table 2.-Estimated proportion and abundance of Arctic grayling in the Nome River by scale age class, 1997.

Statistic	Scale Age								Total
	3	4	5	6	7	8	9	10	
Pilgrim R.									
Sample Size	21	6	36	55	65	61	26	8	278
Estimated Prop.	0.076	0.022	0.130	0.198	0.234	0.220	0.094	0.029	1.00
SE of Proportion	0.016	0.009	0.020	0.024	0.025	0.025	0.017	0.010	
Est. Abundance	51	15	88	134	159	149	63	19	678
SE of Abundance	15	7	22	32	37	35	17	8	172

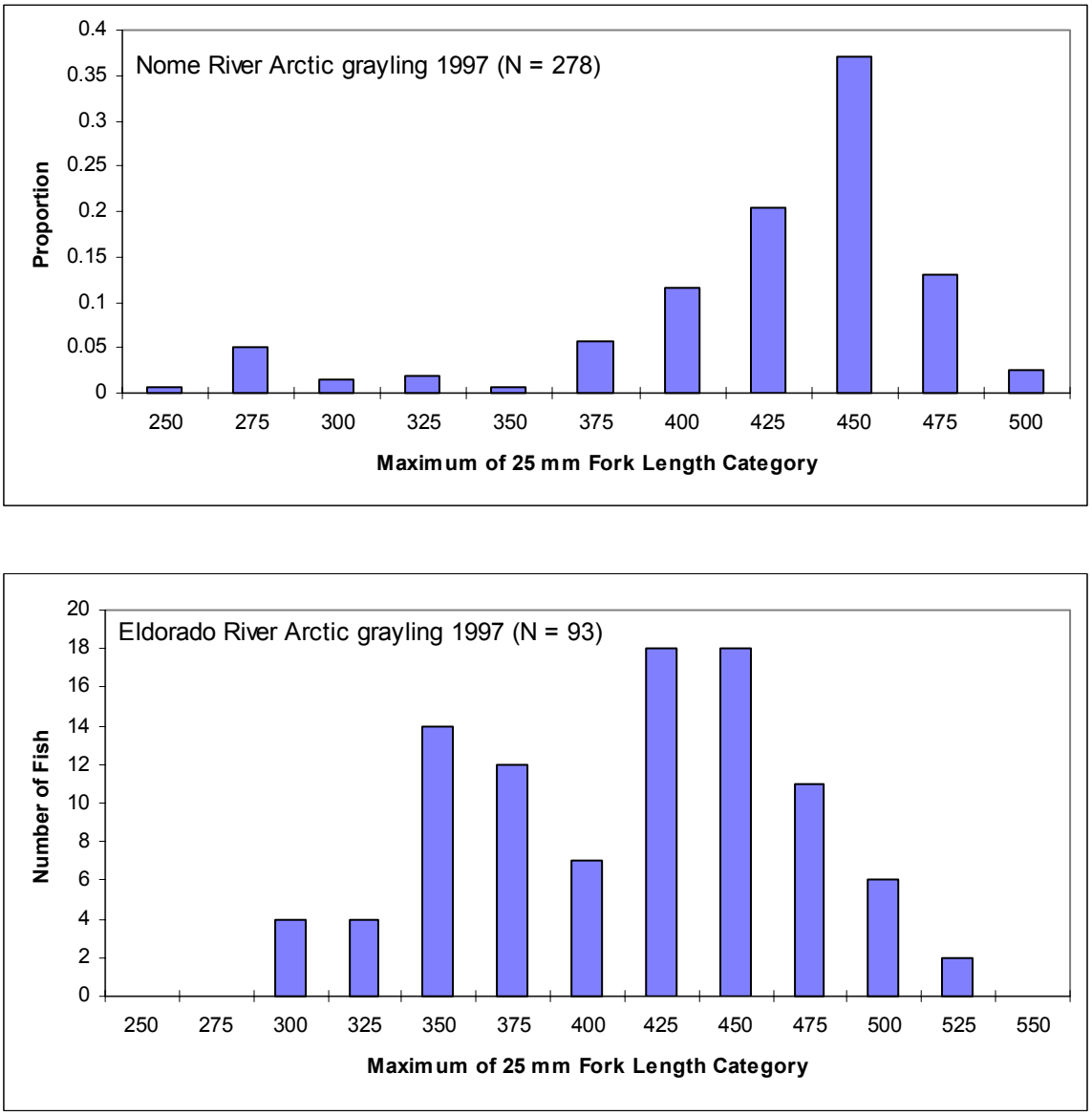

Figure 6.-Length composition estimates in 25 mm increments of Arctic grayling in the Nome River and length distribution from the Eldorado River in 1997.

Table 3.-Estimates of length composition and abundance of Arctic grayling from the Nome River, and length distribution of the Eldorado River sample by 25 mm FL increments, 1997.

Statistic	Upper Bound of Fork Length Category												Total
	250	275	300	325	350	375	400	425	450	475	500	525	
Nome River													
Sample Size	2	14	4	5	2	16	32	57	103	36	7		278
Estimated Prop.	0.007	0.050	0.014	0.018	0.007	0.058	0.115	0.205	0.371	0.130	0.025		1.00
SE of Proportion	0.005	0.013	0.007	0.008	0.005	0.014	0.019	0.024	0.029	0.020	0.009		
Est. Abundance	5	34	10	12	5	39	78	139	251	88	17		678
SE of Abundance	4	11	5	6	4	12	20	33	55	22	7		179
Eldorado River													
Sample Size			4	4	14	12	7	18	18	11	6	2	74
Estimated Prop.			0.042	0.042	0.146	0.125	0.073	0.188	0.188	0.115	0.063	0.021	1.00
SE of Proportion			0.021	0.021	0.036	0.034	0.027	0.040	0.040	0.033	0.025	0.015	

in 1997. Of these, six carried tetracycline marks from 1994 or 1995, including one fish which had lost its tag. In 1996, 11 of 75 Arctic grayling were captured carried OTC marks. All recaptured fish were killed and frozen whole for later analysis. Otoliths will not be analyzed until the remainder of the sample is collected. Approximately 23 otoliths must be analyzed to validate aging techniques (DeCicco 1995). It was assumed that the sample would be completed in 1997. Because more OTC marked fish are needed, an additional sampling trip will be undertaken in 1998 in an attempt to capture six additional OTC marked fish.

Fish recaptured in 1996 provided additional support for the continuation of this study to conclusion. Of 13 consecutive year recaptures, with scale-ages, only two gave a +1-year age difference, and none of four captured two years apart gave a +2-year age difference (DeCicco *In prep*). Similar data were collected from the Nome River in 1997. Fifteen Arctic grayling which carried tags from 1991 and 1992 resulted in paired ages from time of mark to recapture in 1997. None showed an age difference which accurately depicted the known passage of time (Table 5). One of these showed no change in scale age over the past six years, again pointing out the shortcomings of relying on scale ages to model large, old aged Arctic grayling populations.

SOLOMON RIVER ARCTIC GRAYLING

A sample of Arctic grayling was obtained from the Solomon River in 1997 during a single, two day pass through the system. Only six Arctic grayling were captured and an additional 10 were observed in the 25 km index section. Captured Arctic grayling ranged in fork length from 450 mm to 488 mm. It was concluded that the Arctic grayling population in the Solomon River consists of very few fish.

DISCUSSION

The abundance estimate reported for the Nome River applies only to Arctic grayling >249 mm FL and is thought to be unbiased. It is functionally a whole river estimate since little suitable habitat occurs upstream from the 42 km area sampled, and this area extends downstream to within 1.5 km of the coastal lagoon. Age and size composition estimates similarly apply only to fish larger than 249 mm FL. Since the estimates are based on the entire sample, they are thought to be unbiased for the range of sizes covered, but may be biased high in relation to the entire Arctic grayling population of the river. Since very few small fish were captured or observed in the Nome River, it is thought that if size bias exists, its extent is small.

Both hook and line and beach seines were used to capture fish during both sampling events. Beach seines captured a wider size range of Arctic grayling than hook and line (Appendix A4). Seines can be deployed in only limited areas of the river while hook and line methods can be utilized in the areas where seines cannot be used. It is felt that these two methods are complimentary and maximize the efficiency of sampling effort. Approximately 28% of the Arctic grayling population in the sampled area of the Nome River were captured during the first sampling event using these methods in combination. The recapture rates of fish marked using hook and line and using beach seines were similar and it is felt that both methods capture Arctic grayling equally. Once an Arctic grayling is caught using any method, it may be less likely to take a lure during the second sampling event. No Arctic grayling which were originally marked using hook and line were recaptured with that method, however, the overall recapture rate did not

Table 4.-Mean fork length-at-age of Arctic grayling in Seward Peninsula rivers sampled during 1997.

	Nome River 1991, 1992, 1997			Eldorado R.1988, 1993-1997		
Scale Age	Number of Fish	Mean Length (mm/FL)	Standard Deviation (mm/FL)	Number of Fish	Mean Length (mm/FL)	Standard Deviation (mm/FL)
1	1	125	0	---	---	---
2	1	223	0	---	---	---
3	40	264	21	4	265	19
4	128	320	28	43	310	30
5	154	379	42	59	354	38
6	195	378	42	39	384	35
7	157	419	33	44	413	22
8	125	437	26	58	440	25
9	50	444	19	70	453	23
10	26	455	20	42	465	19
11	1	476	0	19	464	19
12	3	488	6	10	477	13
13	---	---	---	1	453	0

Table 5.-Changes in fork length and scale age determinations of Nome River Arctic grayling marked during 1991 - 1992, and recaptured in 1997.

Marked				1997 Recapture		Change		
Tag No.	Year	Length	Scale Age	Length	Scale Age	Length	Scale Age	Years Passed
52699	1991	399	6	465	8	66	+2	6
52702	1991	310	4	458	8	148	+4	6
52719	1991	378	6	455	8	77	+2	6
52738	1991	244	3	434	8	190	+5	6
52750	1991	458	7	481	7	23	0	6
52758	1991	467	8	482	10	15	+2	6
52795	1992	365	5	442	9	77	+4	5
52811	1992	370	6	473	7	103	+1	5
52830	1992	352	4	455	8	103	+4	5
52861	1991	348	6	438	9	90	+3	6
52870	1991	330	4	453	8	123	+4	6
52950	1992	438	7	463	9	25	+2	5
52972	1992	395	6	436	9	41	+3	5
55009	1992	304	4	436	7	132	+3	5
55172	1992	373	6	455	9	82	+3	5

differ significantly between hook and line and beach seine. Since electrofishing has been found to be unsuccessful as a sampling method in Nome area streams and may harm other species (DeCicco 1992), it is felt that the combination of hook and line and beach seine give the least biased Arctic grayling samples and has become the standard for sampling this species in the Nome area.

As in previous stock assessment work on the Nome River, few small Arctic grayling were captured or observed. However, many small schools of young of the year Arctic grayling were observed along the margins of the river. It is thought that young Arctic grayling may be swept downstream to the coastal lagoon or carried into the Bering Sea and lost to the population. This may be the most significant single factor limiting recruitment to the population. If young of the year Arctic grayling could be captured and moved to a location where they could survive their first winter, their contribution to the population might be encouraged. A project is currently under consideration to accomplish this end and enhance the natural recruitment process in the Nome River. Data from this study were used to make a recommendation to the Alaska Board of Fisheries which closed the Nome and Solomon rivers to sport fishing for Arctic grayling at the December 1997 BOF meeting.

It is recommended that the status of Nome area Arctic grayling populations continue to be assessed on a rotational basis in order to determine trends in populations. Collection of additional OTC marked Arctic grayling from the Eldorado River is desired, and should be carried out in 1998 if time allows.

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LITERATURE CITED

ADF&G (Alaska Department of Fish and Game). *Unpublished*. Trophy fish program history (1967-1995). Alaska Department of Fish and Game, Juneau.

Alt, K. T. 1978. Inventory and cataloging of sport fish and sport fish waters of western Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1977-1978, Project F-9-10, 19(G-I).

Alt, K. T. 1979. Inventory and cataloging of sport fish and sport fish waters of western Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1978-1979, Project F-9-11, 20(G-I).

Alt, K. T. 1980. Inventory and cataloging of sport fish and sport fish waters of western Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1979-1980, Project F-9-12, 21(G-I).

Alt, K. T. 1986. Inventory and cataloging of sport fish and sport fish waters of western Alaska. Part B: Nowitna and Fish\Niukluk River study, western Alaska creel census, and sheefish enhancement assessment. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1984-1985, Project F-9-17, 26(G-I), Juneau.

LITERATURE CITED (Continued)

Bailey, N. J. T. 1951. On estimating the size of mobile populations from capture-recapture data. Biometrika 38: 293-306.

Bailey, N. J. T. 1952. Improvements in the interpretation of recapture data. Journal of Animal Ecology 21: 120-127.

Cochran, W. J. 1977. Sampling techniques, third edition. John Wiley and Sons, New York, New York.

Conover, W. J. 1980. Practical nonparametric statistics, second edition. John Wiley and Sons, New York.

DeCicco, A. L. 1990. Seward Peninsula Arctic grayling study 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-11, Anchorage.

DeCicco, A. L.. 1991. Seward Peninsula Arctic grayling study 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-24, Anchorage.

DeCicco, A. L. 1992. Assessment of selected stocks of Arctic grayling in streams of the Seward Peninsula, Alaska, during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-13, Anchorage.

DeCicco, A. L. 1993. Assessment of selected stocks of Arctic grayling in streams of the Seward Peninsula, Alaska, during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-36, Anchorage.

DeCicco, A. L. 1994. Assessment of selected stocks of Arctic grayling in streams of the Seward Peninsula, Alaska, During 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-12, Anchorage.

DeCicco, A. L. 1995. Assessment of selected stocks of Arctic grayling in streams and a survey of Salmon Lake, Seward Peninsula, Alaska, 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-19, Anchorage.

DeCicco, A. L. 1996. Assessment of selected stocks of Arctic grayling in streams and a survey of Salmon Lake, Seward Peninsula, Alaska, 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-21, Anchorage.

DeCicco, A. L. *In prep*. Assessment of Arctic grayling in selected streams of the Seward Peninsula, 1997. Alaska Department of fish and Game, Fishery Data Series, Anchorage.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Ststistical Association. 66:708-713.

Howe, A. H., G. Fidler and M. J. Mills. 1995. Harvest, catch and participation in Alaska sport fisheries during 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-24, Anchorage.

Howe, A. H., G. Fidler, A. E. Bingham and M. J. Mills. 1996. Harvest, catch and participation in Alaska sport fisheries during 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-32, Anchorage.

Howe, A. H., G. Fidler, C. Olnes, A. E. Bingham and M. J. Mills. 1997. Harvest, catch and participation in Alaska sport fisheries during 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-29, Anchorage.

Merritt, M. F. 1989. Age and length studies and harvest surveys of Arctic grayling on the Seward Peninsula, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 79, Juneau.

Mills, M. J. 1981. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22(SW-I-A), Juneau.

Mills, M. J. 1982. Alaska statewide sport fish harvest studies (1981). Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23(SW-I-A), Juneau.

Mills, M. J. 1983. Alaska statewide sport fish harvest studies (1982). Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24(SW-I-A), Juneau.

Mills, M. J. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25(SW-I-A), Juneau.

LITERATURE CITED (Continued)

Mills, M. J. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26(SW-I-A), Juneau.

Mills, M. J. 1986. Alaska statewide sport fish harvest studies (1985). Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-10-1, 27(RT-2), Juneau.

Mills, M. J. 1987. Alaska statewide sport fish harvest studies (1986). Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau.

Mills, M. J. 1988. Alaska statewide sport fish harvest studies (1987). Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau.

Mills, M. J. 1989. Alaska statewide sport fish harvest studies (1988). Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau.

Mills, M. J. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage.

Mills, M. J. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage.

Mills, M. J. 1992. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-40, Anchorage.

Mills, M. J. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-42, Anchorage.

Mills, M. J. 1994. Harvest, catch, and participation in Alaska sport fisheries during 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-28, Anchorage.

Seber, G. A. F. 1982. The estimation of animal abundance and related parameters, second edition. Charles Griffin and Co., Ltd. London, U.K.

Thompson, S. K. 1987. Sample size for estimating multinomial proportions. The American Statistician 41(1):42-46.

Yole, F. 1975. Methods of aging fish species common to rivers and lakes of the northern Yukon Territory, 1972-1974. *in* L. Steigengerger, M. Elson, P. Bruce, Y. Yole editors. Northern Yukon Fisheries Studies 1971-1974. Volume 2. Prepared for Environmental Social Program, Northern Pipelines.

APPENDIX A

Appendix A1.-List of numbered tags and finclips used to mark Arctic grayling from the Nome River in 1997.

Location	Month	No. Fish	Tag Numbers	Color	Fin Clip
Upper Pilgrim R.	July	87	14250 - 14336	Gray	Upper Caudal
	July	57	14337 - 14393	Gray	Lower Caudal
	July	15	14394 - 14408	Gray	Right Ventral
	July	21	14409 - 14429	Gray	Left Ventral

Appendix A2.-Age-length distribution of Arctic grayling sampled from the Nome River in 1997.

Length	Age												
(mm)	1	2	3	4	5	6	7	8	9	10	11	12	Total
101-125	2												2
126-150	1												1
151-175		1											1
176-200		4											4
201-225		3											3
226-250			9										9
251-275			14										14
276-300			4										4
301-325			1	3	1								5
326-350				1	1								2
351-375				2	9	5							16
376-400				1	17	9	4	2					33
401-425					6	19	21	9	2				57
426-450					2	21	33	32	14	1			103
451-475						1	6	16	7	6			36
476-500							1	2	3	1			7
501-525													
Total	3	8	28	7	36	55	65	61	26	8			297

Appendix A3.-Age-length distribution of Arctic grayling sampled from the Eldorado River in 1997.

	AGE													
Length (mm)	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
101-125														
126-150														
151-175														
176-200														
201-225														
226-250														
251-275														
276-300				4										4
301-325				4										4
326-350				5	7									12
351-375				1	10	1								12
376-400					5	2								7
401-425						6	5	3	2	1				17
426-450					1	2	4	4	5	3	2			21
451-475										3	1	1	1	6
476-500										2	1	3		6
501-525										1	1			2
Total				14	23	11	9	7	7	10	5	4	1	91

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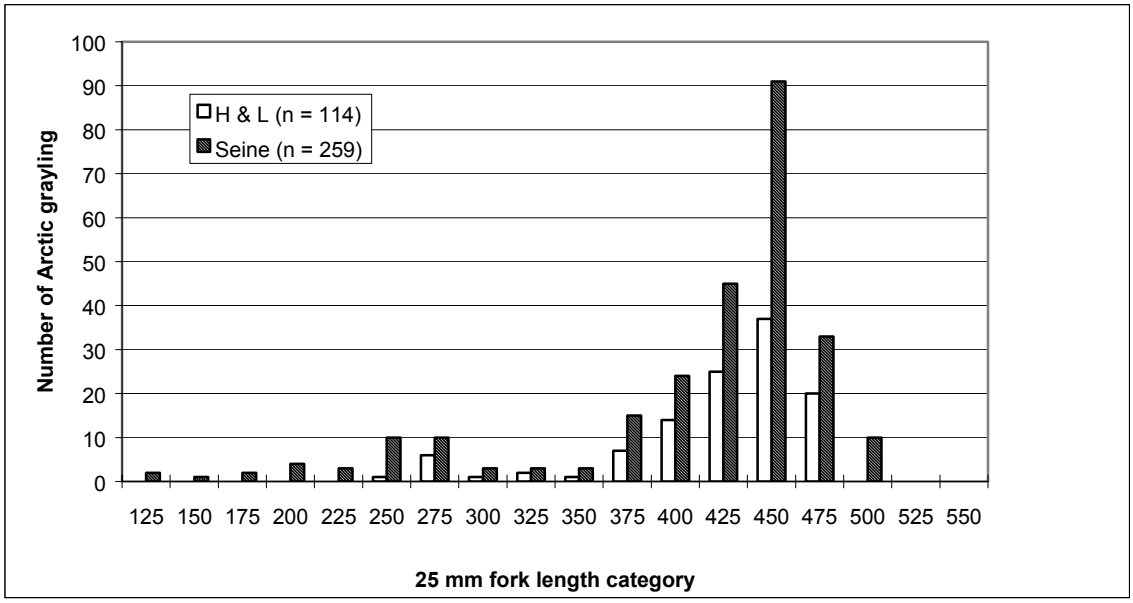
Appendix A4.-Length distribution of Arctic grayling captured from the Nome River in 1997 using beach seine and hook and line.



APPENDIX B

Appendix B.-Data files used to estimate parameters of Arctic grayling populations on the Seward Peninsula in 1997.

Data File[a]	Description
W0120LA5.DTA	Data for Arctic grayling captured from the Nome River during 1997.
W0110LA5.DTA	Data for Arctic grayling captured from the Eldorado River during 1997.

[a] Data files have been archived at, and are available from the Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services, 333 Raspberry Road, Anchorage, Alaska 99518-1599.